Testing Cosmologies Beyond the Standard Model with Euclid

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The Euclid mission, a large international collaboration, will be one of the most important observational efforts in cosmology in the upcoming years. It will provide a catalogue of galaxies covering an unprecedented cosmological volume allowing a precise determination of the statistical properties of the matter distribution at large scales. This in turn is expected to shed light on the Dark Energy and the mysterious accelerated expansion of the Universe, on the nature of Dark Matter, on neutrino masses and several other open problems in fundamental physics and astrophysics.
The Astronomical Observatory of Trieste and the University of Trieste are deeply involved in the preparation for the mission and the development of the data analysis pipelines.

One specific line of work is focused on the exploitation of the spectroscopic galaxy sample and the analysis of clustering properties of galaxies at large scales. Codes providing measurements of the galaxy power spectrum or 2-point correlation function, the main observables in large-scale structure studies, are being developed here, along with the implementation of theoretical models for their interpretation, for the moment mostly limited to a CDM cosmology. The proposed thesis will focus on extending a likelihood analysis code to explore models beyond the standard LambdaCDM.

There are several possible directions of work, including cosmologies with massive neutrinos, non-Gaussian initial conditions from inflationary models or non-standard dark matter models. Given the rapidly evolving nature of the field, the specific topic will be decided at the start of the doctorate, taking into account as well the interests of the candidate.

The work will be, for the most part, of numerical nature, but with the possibility of exploring new analytical tools. More in general, it will expose the student to a variety of topics in the study of the Large-Scale Structure of the Universe, from the estimation of correlation functions from galaxy catalogues to their, state-of-the-art, theoretical modelling from Cosmological Perturbation Theory.

The thesis will be developed under the supervision of Dr. Emiliano Sefusatti, lead of the Higher Order Correlation Functions WP and member of Nonlinear Modelling WP, part of the Euclid Galaxy Clustering Science Working Group. The candidate will work in close collaboration with a local group of students and postdocs at the University, the Observatory and SISSA and will be part of teams encompassing several Euclid groups in Italy and Europe.

At the end of the PhD program, the candidate will have built up all necessary expertise to provide an important contribution to the actual data analysis of Euclid or other competing galaxy surveys lead by international collaborations like DESI and to extend their data analysis to test interesting cosmological models following the latest theoretical proposals.